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Enhanced lateral drift sensors: concept and development

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Future experiments in particle physics require few-micrometer position resolution in their tracking detectors. Silicon is today's material of choice for high-precision detectors and offers a high grade of engineering possibilities. Instead of scaling down pitch sizes, which comes at a high price for increased number of channels, our new sensor concept seeks to improve the position resolution by increasing the lateral size of the charge distribution already during the drift in the sensor material. To this end, it is necessary to carefully engineer the electric field in the bulk of this so-called enhanced lateral drift (ELAD) sensor. This is achieved by implants with different values of doping concentration deep inside the bulk which allows for modification of the drift path of the charge carriers in the sensor.

In order to find an optimal sensor design, detailed simulation studies have been conducted using SYNOPSYS TCAD. The parameters that need to be defined are the geometry of the implants, their doping concentration and the position inside the sensor. Process simulations are used to provide the production-determined shapes of the implants in order to allow for a realistic modelling.

Results of a geometry optimisation are shown realising an optimal charge sharing and hence position resolution. A position resolution of a few micrometer was achieved by using deep implants without relying on a Lorentz drift or tilted incident angle. Additionally, a description of the multi-layer production process is presented, which represents a new production technique allowing for deep bulk engineering.

Primary authors: Ms VELYKA, Anastasiia (DESY Hamburg); Dr JANSEN, Hendrik (DESY Hamburg)

Presenter: Ms VELYKA, Anastasiia (DESY Hamburg)

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